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**SENATE COMMITTEE ON AGRICULTURE, LIVESTOCK & IRRIGATION**

February 12, 2009 Hearing on Senate Bill 300

Testimony of John Lammers, Fertilizer Advisory Committee member

Mr. Vice Chairman, members of the committee, for the record my name is John Lammers. I am the owner of Lammers Feed and Seed in Harlowtown which is also a retailer of fertilizers. I am a member of the Fertilizer Advisory Committee.

Some 38 years ago, the 1971 Montana Legislature passed legislation which provides an assessment for research and education programs. The purpose was to "improve Montana's economy by providing farmers and ranchers the most accurate information possible about fertilizer use and soil management for greatest profits consistent with environmental protection on the many varied soil and climatic conditions of the states."

These research and education programs are administered by the Montana State University directors of the Agricultural Experiment Station and Extension Service with direct input from the Fertilizer Advisory Committee. The committee consists of five agricultural producers and two fertilizer industry representatives. The directors of the Montana Department of Agriculture (Ron de Yong), the Agricultural Experiment Stations (Dr. Jeff Jacobsen) and the Extension Service (Dr. Doug Steele) provide overall leadership.

In addition to the research and education components, a portion of the fertilizer act supports regulation in the Montana Department of Agriculture. The current assessment of 60 cents/ton is distributed: 25 cents/ton to the Montana Department of Agriculture for regulatory programs, 35 cents/ton (minus a one per cent Montana Department of Agriculture administrative fee) split equally between the Agricultural Experiment Station for research and the Extension Service for education.

In Senate Bill 300, the 35 cents/ton for research and education increases to 75 cent/ton and changes the percentage from 50 per cent for research and 50 per cent for education to 75 per cent for research and 25 percent for education to assure the vast majority of the increase goes to research. The education portion increases slightly with the bulk of the increase going to research. This legislation does not increase the 25 cent fee for regulation.

Senate Bill 300 provides for research which has economic and environment benefits to not only Montana agriculture but all Montanans. With many fertilizers costing $500 per ton and more, the 40 cents per ton increase in the fertilizer check-off is minimal. The cost goes from 60 cents per ton to $1 per ton. We have more crops today and it's more important that ever to assure efficient fertilizer use to generate income for a healthy agricultural economy.

Please support Senate Bill 300. Thank you. Mr. Vice Chairman.

# Soil Nitrous Oxide Emissions from a Continuous Wheat Cropping System in Montana

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**Fertilizer Facts**

Fertilizer √off

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## Introduction

Nitrous oxide ($N_2O$) is a trace gas in the atmosphere that has come under increasing scrutiny because it contributes to global warming and destruction of the stratospheric ozone layer. Human alterations of the global N cycle, including the use of N fertilizer, are known to promote the release of $N_2O$ from soils into the atmosphere. Nitrous oxide production in soils occurs as a result of two microbial processes: 1) nitrification of ammonium and ammonium-producing fertilizers (e.g. urea) under aerobic conditions and 2) denitrification of nitrate under anaerobic conditions (Fig.1). During the past 250 years there has been a 17% increase in the atmospheric $N_2O$ concentration to its present level of 316 parts per billion. Agriculture is reported to account for 65-70% of global anthropogenic emissions, and fertilizer N use (commercial and manure) is considered the primary contributor by the International Panel on Climate Change (IPCC, 2001). Regional and global estimates of $N_2O$ production from agriculture have frequently been adopted using IPCC methodology. Beginning in 1997, IPCC methodology assumed as a default that 1.25% of all N inputs, including fertilizer N, are lost directly as $N_2O$. This default value was developed from databases currently available at the time, most of which came from regions that were considerably more humid than Montana. Given that soil $N_2O$ emissions are known to be affected by differences in cropping systems and climate, there is uncertainty as to the accuracy of the 1.25% default value to Montana agriculture. This study was undertaken to describe seasonal patterns of $N_2O$ release from a continuous wheat cropping system and provide an estimate of the effect of N fertilization on $N_2O$ emission losses.

### Methods

Nitrous oxide gas samples were collected over two years (Apr. 14, 2004 to Apr. 15, 2006) at the Montana State University – Arthur Post Farm in Bozeman. The soil at the site is classified as an Amsterdam silt loam (fine-silty, mixed, superactive, frigid Typic Haplustolls) with pH 7.2, and organic matter content of 1.5% in the surface 8 in. The field study was part of a larger cropping system study, but only the results from the no-till winter wheat – spring wheat rotation are presented here. The wheat-wheat system was divided into subplots representing three target levels of available N, including a low-unfertilized regime, a moderate available N regime (90 lb N/ac), and a high available N regime (180 lb N/ac). The treatments were replicated four times. Available N pool was estimated from the sum of soil $NO_3$-N (0–24 in.) plus fertilizer N applied, with the fertilizer N application rates in the moderate and high regimes calculated by the difference between soil $NO_3$-N tests and the target N level. Fertilizer N applications (as urea) were equivalent to 156 and 218 lb N/ac over two years for the moderate and high N regimes, respectively. Gas sampling was conducted using static chamber techniques. Gas samples were collected from the headspace during the early to mid-afternoon (1 – 3 p.m.). The concentration of $N_2O$ in the container was determined using a gas chromatograph.

### Results

Nitrous oxide flux vs. time profiles (Fig. 2) from the continuous wheat rotation revealed that emissions were episodic and responsive to periods of high soil water-filled pore space and availability of N substrate (soil or fertilizer). Examination of the curves reveals that N fertilization was perhaps the single most important event that stimulated an increase in $N_2O$ emissions. The elevation in emissions occurred within a week following fertilization, and peaked after approximately 2-4 weeks. The duration of elevated flux above background (>2.0 μg $N_2O$-N $m^2$/h) for spring applications in 2004 and 2005 was approximately 10 weeks, but extended somewhat longer for the fall application in 2005 (Sept. 30). The majority of $N_2O$ losses during the 10-wk period following fertilization were probably a result of nitrification, except in the fall 2005, when denitrification may have been important as soil water contents were high and frequently exceeded >70% water-filled pore space. In addition to N fertilization, freeze-thaw cycles in the winter or early spring were also important in stimulating significant $N_2O$ emission activity.

Emissions during these periods were likely a result of denitrification, as rises in air temperature triggered snowmelt and resulted in saturated conditions near the soil surface. Together, the 10 week post-N application and freeze-thaw cycle periods account for 84% of $N_2O$ emissions over a two year period. When $N_2O$ emissions were summed, the results showed that only modest levels of $N_2O$ losses were observed (Table 1). Fertilizer induced emissions were equivalent to 0.43% of the applied N (mean of moderate and high). This is considerably below the IPCC 1.25% default value, and suggests emission of $N_2O$ in semi-arid regions are more modest than suggested by IPCC default methodology.

**Fertilizer Fact:**
Nitrogen fertilization results in an elevation in $N_2O$ emissions from a Montana soil, but the losses (0.43% of applied N) are considerably lower than the IPCC mean default value of 1.25%.

**Reference:**

Intergovernmental Panel on Climate Change. 2001. Climate change 2001: Synthesis report. Summary for Policy makers. IPCC Plenary XVII. Wembley, UK., Sept. 24–29.

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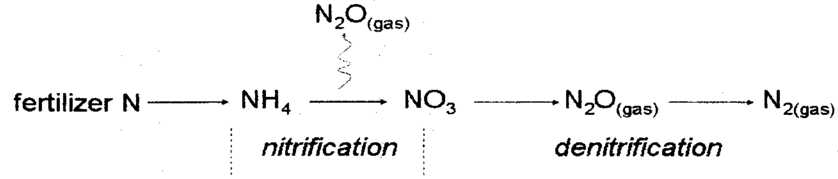


Figure 1. Nitrous oxide production from soils occurs during both nitrification and denitrification.

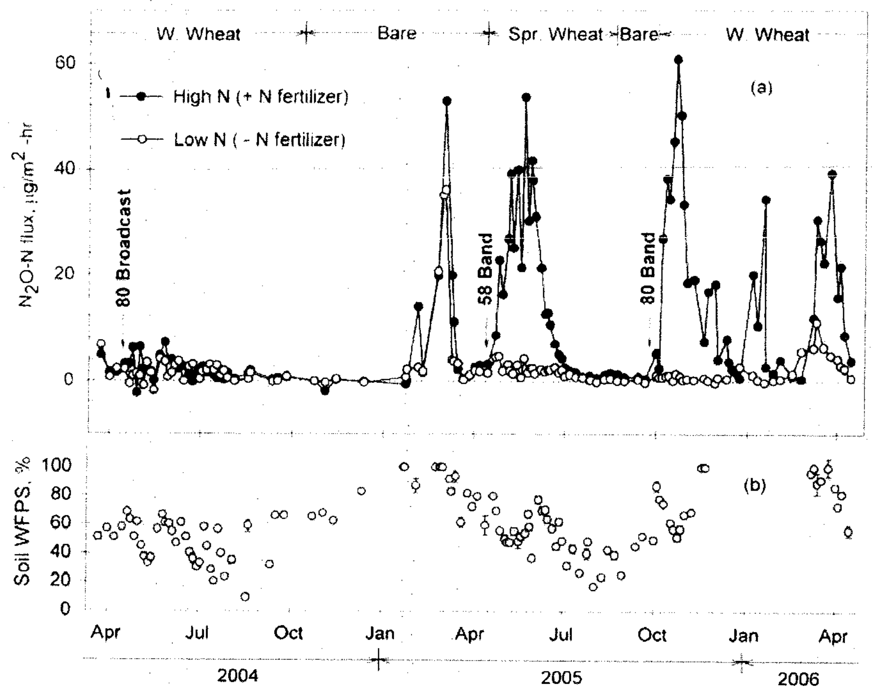


Figure 2. **a)** Nitrous oxide emissions over time for a continuous wheat system at two N management levels (moderate regime not shown for clarity). Arrows indicate date, amount of applied N (lb N/ac), and method of N placement. **b)** Percent of soil water-filled pore space (Soil WFPS) over time (mean of two N levels).

Table 1. Estimated cumulative emissions of $N_2O$, fertilizer induced emissions (FIE) and fraction of applied N fertilizer lost as $N_2O$ over two years for a winter wheat – spring cropping system at 3 available N management regimes.

| Available N regime | Total N applied over 2 years | Cumulative $N_2O$-N losses over 2 years | FIE* of $N_2O$-N over 2 years | Fraction of applied N loss as $N_2O$ |
|---|---|---|---|---|
| | (lb N/ac) | (lb N/ac) | (lb N/ac) | (%) |
| Low | 0 | 0.26 | - | - |
| Moderate | 156 | 0.96 | 0.70 | 0.45 |
| High | 218 | 1.17 | 0.91 | 0.42 |

* FIE = Fertilizer Induced Emission: Cumulative $N_2O$-N losses from fertilizer applications (moderate or high).